ENGINEERING CHANGE NOTICE

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1. ECN 643404

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [X] (gmg 8/25/97) Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	B. C. Simpson, LMHC, R2-12 373-5915	[] Yes [X] No	08/16/97
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	Tank 241-TY-106	NA	NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	WHC-SD-WM-ER-482, Rev. 0B	NA	NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

Add Appendix B, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-TY-106.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[X]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-TY-106 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

15. Distribution (include name, MSIN, and no. of copies)

Central Files	A3-88	K. M. Hall	R2-12
DOE Reading Room	H2-53	K. M. Hodgson	R2-11
TCSRC	R1-10		
File	H5-49	J. Jo	R2-12
B. C. Simpson	R2-12		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
NA		

21. Approvals

Signature	Date	Signature	Date
Design Authority		Design Agent	
Cog. Eng. M. J. Kupfer M. J. Kupfer	8-18-97	PE	
Cog. Mgr. K. M. Hodgson K. M. Hodgson	8-19-97	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other J. Jo J. Jo	8-19-97	Other	
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

Tank Characterization Report for Single-Shell Tank 241-TY-106

B. C. Simpson
Lockheed Martin Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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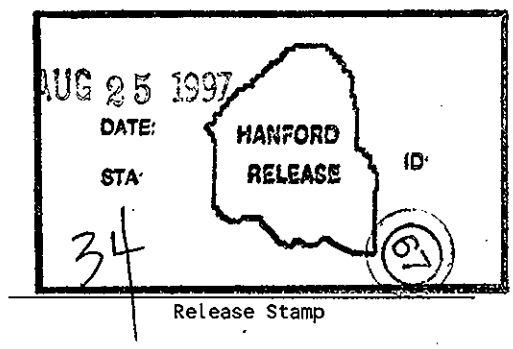
Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-TY-106 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.



Release Approval 8/25/97 Date

Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-482	Page 1 of A

(2) Title
Tank Characterization Report for Single-Shell Tank 241-TY-106

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 07/07/95 on EDT-611426.	A.T. Dicenso	J.G. Kristofzski
0-A RS	Incorporate per ECN-625682.	L.M. Sasaki 8/31/95	J.G. Kristofzski 8/31/95
0-B RS	Incorporate per ECN-625687.	L.M. Sasaki	J.G. Kristofzski 9/19/95
0-C RS	Incorporate per ECN-643404	M.J. Kupfer 8-15-97	K.M. Hodgson 8-19-97

APPENDIX B

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TY-106

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APPENDIX B

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TY-106

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-TY-106 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task. The following evaluation provides a best-basis inventory estimate for chemical and radionuclide components in tank 241-TY-106.

B1.0 CHEMICAL INFORMATION SOURCES

Appendix A provides mean characterization results and inventory estimates from the two core composite samples obtained in 1985 from tank 241-TY-106. A waste density of 1.37 g/mL and a waste volume of 64 kL (17 kgal) have been established as the basis values for inventory calculation (Weiss and Mauss 1987b and Hanlon 1997, respectively).

Two auger samples were subsequently obtained for safety screening analysis in 1995, however the data obtained did not contribute to the chemical information available (Jo 1995). The HDW model (Agnew et al. 1997a) provides tank contents estimates, derived from process flowsheets and waste volume records.

B2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The sample based inventory estimate from Appendix A and the inventory estimate from the HDW model (Agnew et al. 1997a) for tank 241-TY-106 are shown in Tables B2-1 and B2-2. Each estimate, however, has a different volume and density basis.

The HDW inventory estimates use a waste volume of 79.5 kL (21 kgal), and a waste density of 0.455 g/mL. The sample based inventory uses a volume of 64 kL (17 kgal), and a measured bulk density of 1.37 g/mL as bases. Because of the large difference between the two estimates for the mass basis (relative percent difference [RPD] = 83.7 percent), many significant differences between the sample-based and HDW model inventories are observed.

Estimates obtained from the two methods for most analytes vary by a factor of two or more. The chemical species are reported without charge designation per the best-basis inventory convention.

Table B2-1. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-TY-106.

Analyte	Sampling inventory estimate[a] (kg)	HDW model inventory estimate[b] (kg)	Analyte	Sampling inventory estimate[a] (kg)	HDW model inventory estimate[b] (kg)
Al	603	163	NH_3	NR	0.0277
Ag	2.44	NR	Na	9,250	19,800
Ba	68.4	NR	Ni	6.02	0.162
Bi	46.2	0	NO_2	619	26.3
Ca	NR	295	NO_3	15,000	3,120
Cd	2.51	NR	OH	NR	302
Cl	133	5.85	Pb	NR	0
Co	NR	NR	P as PO_4	5,200	21.3
Cr	12.5	0.288	Si	7,870	12,100
F	<76.3	0	SO_4	1,520	23.5
Fe	4,030	711	Sr	NR	0
FeCN/CN	NR	0	TIC as CO_3	110	96.4
Hg	NR	0	TOC	202	0.008
K	NR	1.06	U_{TOTAL}	727	0.627
La	NR	0	Zr	57.1	0
Mn	48.8	0	H_2O (Wt%)	34.8	NR
			Density (kg/L)	1.37	0.455

HDW = Hanford Defined Waste
NR = Not reported
[a] Appendix A
[b] Agnew et al. (1997b).

Table B2-2. Sample- and Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-TY-106.

Analyte	Sampling inventory estimate[a] (Ci)	HDW model inventory estimate[b] (Ci)	Analyte	Sampling inventory estimate[a] (Ci)	HDW model inventory estimate[b] (Ci)
^{241}Am	4.28	0.00229	^{14}C	0.103	0.00119
^{137}Cs	1,930	38.9	^{60}Co	2.74	2.73 E-04
^{129}I	5.86	1.56 E-05	$^{239/240}Pu$	3.54	0.0112
^{90}Sr	12,000	19.4	^{99}Tc	10.7	0.00828
Total α	17.3	NR	Total β	39,700	NR

HDW = Hanford Defined Waste
NR = Not reported
[a] Appendix A, radionuclides reported as of sample analysis date
[b] Agnew et al. (1997b), radionuclides decayed to January 1, 1994.

B3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed in order to identify potential errors and/or missing information that would influence the sample-based and HDW model component inventories. The types and volumes of solids accumulated in tank 241-TY-106 reported by various authors is compiled in Tables B3-1, B3-2, and B3-3.

B3.1 CONTRIBUTING WASTE TYPES

The process history documents indicate the tank received mostly tributyl phosphate/uranium recovery (TBP/UR) waste while the tank was active. However, according to Agnew et al. (1997b), a significant amount of the waste transferred to the tank was of an unknown origin and is hypothesized to be a part of the lag storage space used in the 242-T Evaporator. Most of the supernate was removed from the tank in 1959, after it was confirmed to be leaking. The tank now contains sludge from the waste it received in 1953 and 1954, and diatomaceous earth that was added as a stabilizing agent in 1972.

Tank 241-TY-106 went into service in June 1953, receiving uranium recovery waste through the cascade inlet from tank 241-TY-105 (Anderson 1990, Agnew et al. 1997a). Uranium recovery waste resulted from the tributyl phosphate uranium extraction process

employed at U Plant in the 1950's. Metal waste sludge, which originated from uranium fuel dissolution in the bismuth phosphate process, was sluiced from waste storage tanks, and the uranium in the waste was separated from fission products using a solvent extraction process based on tributyl phosphate.

According to Anderson (1990) and Jungfleisch (1984), tank 241-TY-106 received a total of nearly 20,070 kL (5,300 kgal) of this waste during 1953 and 1954. Through the third quarter of 1954, most of the waste was transferred periodically to tank 241-TX-118 for concentration in the 242-T Evaporator. In late 1954, the tank was filled to near capacity, and there were no further transfers until 1959. Agnew et al. (1997a) differs from Anderson (1990) and Hanlon (1997) in the amount of waste remaining in the tank.

Table B3-1. Waste Inventory of Tank 241-TY-106 (Hanlon 1997).

Waste	Volume (kL)	Volume (kgal)
Sludge	64	17
Saltcake	0	0
Supernatant	0	0
Drainable Interstitial Liquid	0	0
Total Waste	64	17

Table B3-2. Expected Solids for Tank 241-TY-106.

Reference	Waste Type
Anderson (1990)	TBP, Diatomaceous earth
SORWT Model (Hill et al. 1995)	TBP, Diatomaceous earth
WSTRS (Agnew et al. 1997a)	TBP (UR), Diatomaceous earth
HDW Model (Agnew et al. 1997b)	UR, Diatomaceous earth

SORWT = Sort on radioactive waste type
WSTRS = Waste Status and Transaction Record Summary

Table B3-3. Hanford Defined Waste Model Solids for Tank 241-TY-106

HDW solids layer	kL	kgal
Uranium Recovery/Tributyl Phosphate	3.8	1
Diatomaceous Earth	75.7	20
Total HDW Volume	79.5	21

B3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

Tank 241-TY-106 appears to contain a small amount of sludge. Review of Anderson (1990) and Agnew et al. (1997a, 1997b) indicates the following chain of events is probable to have occurred:

Tank 241-TY-106 was placed into service in 1953. It received TBP/UR waste cascaded from tank 241-TY-105. This waste would be largely free of TBP/UR particulate, however a small amount of TBP/UR waste may have settled out and formed a sludge heel. The tank continued receiving supernatant until 1959. From 1953 to 1956, the clarified supernatant was transferred to tank 241-TX-118 as feed for the 242-T Evaporator. This material would eventually be concentrated and distributed to other tanks as 242-T Evaporator/crystallizer salt cake (T1SltCk).

Surveillance data in 1959, showed the tank to be a leaker, therefore, most of the remaining supernatant waste was transferred to tank 241-TY-103. To mitigate any further leaking from this tank, 30 tons of diatomaceous earth was added to the tank in 1972 to absorb the residual liquid. No transactions have occurred since then. The tank was stabilized and partially interim isolated in 1978.

B3.3 ENGINEERING EVALUATION OF TANK SAMPLE INFORMATION

An estimate of the waste inventory in tank 241-TY-106 will be derived using information independent from the composition information contained in Weiss and Mauss (1987b).

B3.3.1 TBP/UR Composition Estimate

Table B3-4 provides an estimate of the waste composition in tank 241-TY-106 using the average waste composition from sample data extracted from two tanks with similar wastes (tank 241-TY-105 that cascaded TBP/UR waste into tank 241-TY-106 [Weiss and Mauss 1987a], and tank 241-BX-109 that received TBP/UR waste exclusively [Field et al. 1996]). In-tank photographs of tank 241-TY-106 (Ewer et al. 1997) show that the surface is primarily white-gray in color, dried, and cracked, indicating the presence of diatomaceous earth.

Table B3-4 shows also data for tank 241-TY-106 from the 1985 sampling event. The results are for a single composite. Sample recovery appears to have been average to poor and only one riser was sampled. The sample results are the average of three segments taken from one riser. The core sample analysis were not documented to current QC requirements, however, there is no reason to believe that the samples were not analyzed using good

laboratory practice. Sample recoveries for segments 1 and 2 is stated as being 100 percent. The third segment (segment 4) recovered 33.6 g of material, however, no quantitative statement of recovery was made (Weiss and Mauss 1987b).

The 1995 analysis was conducted on two auger samples. The results do not contain any relevant chemical species information, because only differential scan calorimetry/thermogrametric analysis (DSC/TGA), and total alpha information was collected (Jo 1995).

Table B3-4. Comparison of Tanks Containing TBP/UR Waste: Tanks 241-TY-105, 241-TY-106, and 241-BX-109 (2 Sheets)

Analyte	Tank 241-TY-105 sampling data[a]	Tank 241-BX-109 sampling data[b]	Avg. TBP/UR Composition	Tank 241-TY-106 sampling data[c]
	1985 core sample	1996 core sample		1985 core sample
	μg/g	μg/g	μg/g	μg/g
Al	1,910	1,900	1,910	6,850
Bi	383	NR	383	525
Ca	NR	2,720	2,720	NR
Cl	0	1,200	600	1,510
TIC as CO_3	0	NR	0	1,250
Cr	132	NR	132	142
F	0	NR	0	< 866
Fe	20,900	21,500	21,200	45,800
Hg	0	NR	0	NR
K	NR	NR	NR	NR
La	NR	NR	NR	NR
Mn	163	NR	163	554
Na	115,000	114,000	115,000	105,000
Ni	85.1	NR	85.1	68.3
NO_3	178,000	212,000	195,000	170,000
NO_2	0	19,100	9,600	7,030
Pb	388	NR	388	384
P as PO_4	118,700	67,300	93,000	59,100
Si	368	1,730	1,050	89,300[d]

Table B3-4. Comparison of Tanks Containing TBP/UR Waste: Tanks 241-TY-105, 241-TY-106, and 241-BX-109 (2 Sheets)

Analyte	Tank 241-TY-105 sampling data[a]	Tank 241-BX-109 sampling data[b]	Avg. TBP/UR Composition	Tank 241-TY-106 sampling data[c]
	1985 core sample	1996 core sample		1985 core sample
	μg/g	μg/g	μg/g	μg/g
SO_4	0	20,500	10,300	17,200
Sr	NR	590	590	NR
TOC	805	409	607	2,290
Total U	5,400	18,000	11,700	8,250
Zr	7.31	NR	7.31	648
H_2O (wt%)	39.4	50.9	45.2	34.7
Density (kg/L)	1.53	1.48	1.51	1.37

NR = Not reported
[a] Weiss and Mauss (1987a)
[b] Field et al. (1996)
[c] Weiss and Mauss (1987b)
[d] Result includes contribution from diatomaceous earth
Analytes where the average consists of "NR" and quantitative results, use the quantitative result. Analytes where the average consists of "NR" and zero, use zero.

The TBP process waste composition specified by Hill et al. (1995) at least for iron and nitrate agrees quite well with that specified in GE (1951). Hill et al., however, lists a uranium concentration a factor of three higher than listed in GE. The TBP waste composition specified by Hill et al. differs significantly from that specified by Agnew et al. (1997b) as shown in Table B3-5. In particular, the sodium, nitrate, phosphate, and sulfate concentrations listed by Hill et al. are about a factor of two higher than those listed by Agnew et al. The basis for the flowsheet values listed by Agnew et al. is unknown. Work is in progress to establish more accurately the composition of the TBP process waste sent to tank 241-TY-105. But, until additional data are available, the average composition derived from tanks 241-BX-109 and 241-TY-105 is used in the independent engineering assessment described in this section.

Table B3-5. Tri-butyl phosphate Process Waste Composition (Concentration *M*).

Analytes	Composition* Hill et al. (1995)	Composition Agnew et al. (1997a)
Ca	NR	0.018
Cl	0.0025	0.095
Cr	NR	0.0032
Fe	0.03	0.046
K	NR	0.016
Na	8.87	4.20
Ni	NR	0.0016
NO_3	7.35	3.10
OH	0.09	0.14
PO_4	0.3	0.13
SO_4	0.31	0.14
Radionuclides		
Pu	6.7 E-07	NR
U	0.0061	0.0015

NR = Not reported

*Values reported in GE (1951) are: Fe = 0.024*M*, NO_3 = 6.18*M*, PO_4 = 0.025*M*, U = 0.0026*M*.

B3.3.2 Composition of Diatomaceous Earth

Approximately 30 MT of diatomaceous earth was added to tank 241-TY-106 in 1972, to demonstrate absorption of free liquids in waste tanks (Buckingham and Metz 1974). Diatomaceous earth is the siliceous skeletal remains of single-cell algae. The composition of the diatomaceous earth added to tank 241-TY-106, and the estimated contribution of several selected analytes is provided in Table B3-6.

Table B3-6. Diatomaceous Earth Addition to Tank 241-TY-106.

Chemical compound	Weight percent	Element	Element added (kg)
SiO_2	92.3	Si	12,900
Al_2O_3	1.1	Al	175
Fe_2O_3	2.0	Fe	420
CaO	0.9	Ca	193
MgO	0.4	Mg	72

Table B3-7 presents the sample-based inventory estimate derived from the 1987 data, the estimated inventory derived by the engineering evaluation, and the HDW model based estimate results of the inventories of various analytes in tank 241-TY-106 waste. A set of simplified assumptions forms the basis for the engineering assessment.

The assumptions and observations are based upon best technical judgement pertaining to parameters that can significantly influence tank inventories. These parameters include: (1) correct predictions of contributing waste types, (2) accurate predictions of model flowsheet conditions, fuel processed, and waste volumes, (3) accurate predictions of component solubilities, and (4) accurate predictions of physical parameters such as density, percent solids, void fraction (porosity), etc.

As necessary, the assumptions used can be modified to provide a basis for identifying potential errors and/or missing information that could influence either or both sample- and model-based inventories. The simplified assumptions and observations use for predicting the inventory of several analytes in tank 241-TY-106 are as follows:

1. Only the neutralized TBP process high-level waste (HLW) slurry and the diatomaceous earth introduced into tank 241-TY-106 contributed to solids formation.

2. Radiolysis of NO_3 to NO_2 and any addition of NO_2 to the waste in tank 241-TY-106 for corrosion control purposes are not accounted for in this independent assessment.

3. All Fe and U in the TBP process HLW added to tank 241-TY-105 precipitated as water-insoluble compounds.

4. The currently accepted surveillance volume, the sample data concentrations, and sample data derived density were used in calculating the sample-based inventories.

The surveillance volume, the average analyte concentration (Table B3-4), and average density was used in calculating the engineering assessment based inventories (except for the silicon, aluminum and iron contributions from the diatomaceous earth, which were calculated and added separately). The HDW model based inventories used their internal reference bases.

Table B3-7. Comparison of Inventory Estimates for Tank 241-TY-106 Derived From the 1985 Core Sampling Event, by the Independent Evaluation, and by the Hanford Defined Waste Model. (2 Sheets)

Analyte	Inventory estimate from 1987 sample data[a]	Engineering evaluation derived inventory estimate[b]	HDW model derived inventory estimate[c]
	(kg)	(kg)	(kg)
Al	603	360	163
Bi	46.2	37.2	0
Ca	NR	460	295
Cl	133	58.26	5.85
TIC as CO_3	110	0	96.4
Cr	12.5	12.8	0.288
F	< 76.3	0	0
Fe	4,030	2,500	711
Hg	NR	0	0
K	NR	NR	1.06
La	NR	NR	0
Mn	48.8	15.8	0
Na	9,250	11,200	19,800
Ni	6.02	8.26	0.162
NO_3	15,000	18,900	3,120
NO_2	619	932	26.3
Pb	33.8	37.8	0
P as PO_4	5,200	9,030	21.3
Si	7,870	13,000	12,100
S as SO_4	1,520	1,000	23.5

Table B3-7. Comparison of Inventory Estimates for Tank 241-TY-106 Derived From the 1985 Core Sampling Event, by the Independent Evaluation, and by the Hanford Defined Waste Model. (2 Sheets)

Analyte	Inventory estimate from 1987 sample data[a]	Engineering evaluation derived inventory estimate[b]	HDW model derived inventory estimate[c]
	(kg)	(kg)	(kg)
Sr	NR	57.3	0
TOC	202	58.9	0.008
Total U	727	1,140	0.627
Zr	57.1	0.71	0

NR = Not reported

[a] Weiss and Mauss (1987b)

[b] Based on an average waste composition derived from tanks 241-BX-109 and 241-TY-105, and a contribution of 30 tons of diatomaceous earth.

[c] Agnew et al. (1997b).

B3.4 DOCUMENT ELEMENT BASIS

This section compares the sample based estimate, the engineering assessment, and the inventory estimate calculated by the HDW model for selected analytes. Many of the differences observed between the estimates can be attributed to the differences in their respective mass bases. The HDW density estimate does not appear to be reasonable as a basis for calculating inventories. In other cases, the source term for the analyte in the waste type does not appear to be accurately described.

Aluminum. Although the aluminum inventory values from both the HDW model and the engineering assessment are consistent, this appears to be a case of coincidental agreement, because the concentrations and mass bases used to derive the inventory estimates are very different. The concentrations from the HDW model and the sample data are relatively close (HDW concentration = 4,520 μg/g, sample data concentration = 6,850 μg/g), but are much larger that the engineering estimate concentration value (1,910 μg/g). Furthermore, the uncertainties in the process history identified by Agnew et al. (1997b) suggest that there may have been some Al-enriched waste stream that contributed to the inventory. However, all three estimates are relatively low contributors (< 1 wt%) to the waste mass. The sample derived inventory was selected as the best basis.

Bismuth. Bismuth appears to be present only in trace quantities. All three methods agree that the Bi inventory is very low. The sample derived inventory was selected as the best basis.

Calcium. The sample data did not have a measurement for calcium. Although, the HDW and engineering estimate are in reasonable agreement, this appears to be a case of coincidental agreement, because the concentrations and mass bases used to derive the inventory estimates are very different (HDW concentration = 8,140 μg/g, engineering evaluation concentration = 2,720 μg/g, plus the contribution from diatomaceous earth). Because calcium is not a principal process chemical in the TBP/UR process, the engineering assessment inventory was selected as the best basis inventory.

Iron. The waste in tank 241-TY-106 appears to be richer in iron than those used as comparison tanks in the engineering assessment. In addition, the HDW estimate appears to be influenced by several factors, including the very low density used as a basis for calculation, because its Fe concentration is relatively close to the average concentration determined for TBP/UR waste (engineering assessment concentration = 21,200 μg/g, plus the contribution from diatomaceous earth; HDW model concentration = 19,600 μg/g). The sample derived inventory was selected as the best basis.

Manganese. Manganese appears to be present only in trace quantities. All three methods agree that the Mn inventory is very low. The sample derived inventory was selected as the best basis.

Silicon. All three methods indicate that this analyte will be a principal contributor to the waste. Using 30 tons of diatomaceous earth (46.7 wt% Si; Si = 12,900 kg) as an initial basis, the small contribution from the TBP/UR waste was added to provide a final inventory estimate (13,000 kg). The HDW model result was close to this value (12,000 kg); and the sample data estimate, because it was biased, underestimated the total amount of Si present (7,870 kg). The engineering assessment inventory was selected as the best basis inventory.

Sulfate. Sulfate concentration in TBP/UR appears to be modest, but highly variable. The engineering assessment values ranged from 0 to 20,500 μg/g, providing a mean of 10,300 μg/g. The mean value was within a factor of two of the sample data (17,200 μg/g), however, the HDW value (650 μg/g) was not close at all to the calculated mean value or the observed data. The HDW model assumes that all of the sulfate is soluble, and none is associated with the solids. This assumption is not necessarily appropriate. Because of this wide variation in concentration estimates, the sample derived inventory was selected as the best basis.

Total Hydroxide. Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of

significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997b). The revised total hydroxide inventory based on sample analyses is 4,220 kg, which is a factor of 14 more than the HDW model estimate.

Phosphate. Phosphate concentration in TBP/UR appears to be high, and variable. The engineering assessment values ranged from 67,300 to 118,700 μg/g, providing a mean of 93,000 μg/g. The mean value was within a factor of two of the sample data (59,100 μg/g), however, the HDW value (590 μg/g) was not close at all to the calculated mean value or the observed data. The HDW model assumes that all of the phosphate is soluble, and none is associated with the solids. This assumption is not necessarily appropriate. Because of this wide variation in concentration estimates, the sample derived inventory was selected as the best basis.

Total Inorganic Carbon. Total inorganic carbon appears to be present only in trace quantities. All three methods agree that the TIC inventory is very low. The sample derived inventory was selected as the best basis.

Uranium. Uranium concentration in TBP/UR appears to be modest, and variable. The engineering assessment values ranged from 5,400 to 18,000 μg/g, providing a mean of 11,700 μg/g. The mean value agreed reasonably with the observed sample data (8,250 μg/g), however, the HDW value (17.3 μg/g) was not close to the calculated mean value or the observed data. Because of this wide variation in concentration estimates, the sample derived inventory was selected as the best basis.

B4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-TY-106 was performed, and a best basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task. The results from this evaluation support using the sample data-derived evaluation as the best basis for tank 241-TY-106 in most cases for the following reasons.

1. The engineering evaluation uses sample results from two tanks with similar process histories, which in the absence of additional data is an acceptable approach. However, there are sufficient differences in process history between the basis tanks used and the specific tank in question to render an estimate based on common waste types unsatisfactory, when data on the tank are available. The comparisons between the methods used to determine inventory, especially with the

inventory derived from common waste types, was useful in determining reasonable maximum and minimum values for particular analytes.

2. Although the core sample was not documented to current QC requirements, the 1985 samples were likely analyzed using good laboratory practice. In the case of this sample event, sample recovery of the core segments was biased and incomplete (Weiss and Mauss 1987b), however, because of the simplicity of the process history of this tank, the assumption that the sample largely represents the tank contents is not unreasonable.

3. The analytical data from the 1996 auger sampling event was not sufficiently complete to offer any additional insight to the waste composition.

4. Because of the addition of a relatively large volume of diatomaceous earth to this tank, the HDW model results are highly influenced by this waste addition. On comparison with the analytical data, the bases and assumptions used in the HDW with regards to the diatomaceous earth addition do not seem to be accurate, and the HDW estimates should be discounted.

Best-basis inventory estimates for tank 241-TY-106 are presented in Tables B4-1 and B4-2. The projected inventory is primarily based on a sample data-based evaluation of the tank. The radionuclide inventories shown in Table B4-2 are based on the 1985 core sample results decayed to January 1, 1994, and Agnew et al. (1997b) HDW model estimates.

Table B4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TY-106. (Effective May 31, 1997)

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	603	S	
Bi	46.2	S	
Ca	460	E	
Cl	133	S	
TIC as CO_3	110	S	
Cr	12.5	S	
F	0	E	
Fe	4,030	S	
Hg	0	E	
K	1.06	M	
La	0	M	
Mn	48.8	S	
Na	9.250	S	
Ni	6.02	S	
NO_2	619	S	
NO_3	15,000	S	
OH_{TOTAL}	4,630	C	Based on charge balance with zero SiO_3
Pb	33.8	S	
P as PO_4	5,200	S	
Si	7,870	E	Not included in charge balance, assumed present as SiO_2
SO_4	1,520	S	
Sr	57.3	E	
TOC	202	S	
U_{TOTAL}	727	S	

Table B4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TY-106. (Effective May 31, 1997)

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Zr	57.1	S	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

The inventory values reported in Tables B4-1 and B4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or less frequently, total beta, and total alpha, while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions.

These computer models are described in Kupfer et al. (1997), Section 6.1, and in Watrous and Wootan (1997). Model generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997b). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model. For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. (1997), Section 6.1.10.

Table B4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TY-106, Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.00863	M	
^{14}C	0.103	S	
^{59}Ni	0.0306	M	
^{63}Ni	3.06 E-02	M	
^{60}Co	0.741	S	
^{79}Se	2.52 E-04	M	
^{90}Sr	9,420	S	
^{90}Y	9,420	S	Referenced to ^{90}Sr
^{93}Zr	0.0012	M	
^{93m}Nb	0.00101	M	
^{99}Tc	10.7	S	
^{106}Ru	1.14 E-10	M	
^{113m}Cd	0.00292	M	
^{125}Sb	2.53 E-04	M	
^{126}Sn	3.79 E-04	M	
^{129}I	5.86	S	
^{134}Cs	3.17 E-06	M	
^{137}Cs	1,530	S	
^{137m}Ba	1,440	S	Referenced to ^{137}Cs
^{151}Sm	0.937	M	
^{152}Eu	0.00273	M	
^{154}Eu	0.00492	M	
^{155}Eu	0.206	M	
^{226}Ra	6.86 E-08	M	
^{228}Ra	1.04 E-11	M	
^{227}Ac	3.51 E-07	M	
^{231}Pa	7.62 E-07	M	

Table B4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TY-106, Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{229}Th	2.02 E-09	M	
^{232}Th	3.40 E-13	M	
^{232}U	3.89 E-09	M	
^{233}U	1.93 E-10	M	
^{234}U	2.06 E-04	M	
^{235}U	9.18 E-06	M	
^{236}U	1.77 E-06	M	
^{238}U	2.09 E-04	M	Use ICP derived inventory
^{237}Np	5.11 E-05	M	
^{238}Pu	6.76 E-05	M	
$^{239/240}$Pu	3.54	S	
^{241}Pu	0.00266	M	
^{242}Pu	1.20 E-08	M	
^{241}Am	4.22	S	
^{243}Am	1.60 E-08	M	
^{242}Cm	5.00 E-05	M	
^{243}Cm	1.02 E-06	M	
^{244}Cm	3.79 E-07	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based
NR = Not reported
ICP = Inductively coupled plasma spectroscopy

B5.0 APPENDIX B REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997b, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)*, LA-UR-97-311 Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Buckingham, J. S., and W. P. Metz, 1974, *Characterization of the Effects of Diatomaceous Earth Additions to Hanford Wastes*, ARH-CD-222, Atlantic Richfield Hanford Company, Richland, Washington.

Ewer, K. L., J. W. Funk, R. G. Hale, G. A. Lisle, C. V. Salois, and M. R. Umphrey, 1997, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 West Area*, HNF-SD-WM-ER-351, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

Field, J. G., B. C. Simpson, and R. D. Schreiber, 1996, *Tank Characterization Report for Single-Shell Tank 241-BX-109*, WHC-SD-WM-ER-572, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

GE, 1951, *Uranium Recovery Technical Manual*, HW-19140, General Electric Company, Richland, Washington.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending April 30, 1997*, HNF-EP-0182-109, Lockheed Martin Hanford Corporation, Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort On Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

Jo, J., L. C. Amato, and A. T. DiCenso, 1995, *Tank Characterization Report for Single-Shell Tank 241-TY-106*, WHC-SD-WM-ER-486, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Jungfleisch, F. M., 1984, *Track Radioactive Components Code*, Rockwell Hanford Operations, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^2S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Weiss, R. L., and B. M. Mauss, 1987a, *Data Transmittal Package for 241-TY-105 Waste Tank Characterization*, SD-RE-TI-186, Rev. 0, Rockwell Hanford Company, Richland, Washington.

Weiss, R. L., and B. M. Mauss, 1987b, *Data Transmittal Package for 241-TY-106 Waste Tank Characterization*, SD-RE-TI-181, Rev. 0, Rockwell Hanford Company, Richland, Washington.